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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Evolution of the
Chrysler PowerFlite
Automatic Transmission

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Evolution of the Chrysler PowerFlite Automatic Transmission

PREVIOUS issues have reviewed the desirability of automatic transmissions in general and have minutely examined nine different designs. The fact that no two of the nine were exactly alike illustrates not only the complexity of the problem of connecting the engine to the driving wheels but the variety of possible solutions.

Scope

For some years now the Chrysler Corporation has been in the position of being able not only to observe competitive transmission design and acceptance, but to manufacture and sell through Chrysler-De Soto-Dodge-Plymouth no less than seven major types with fifteen variations of its own semi and full automatic transmissions which have accumulated a tremendous backlog of customer acceptance and service experience. The purpose of this issue is to briefly describe the construction, operation, and lubrication of all of these transmissions, culminating in the new Chrysler PowerFlite automatic transmission, the latest in the field.

The general characteristics of the fourteen progenitors of the PowerFlite are outlined in Table I which is especially recommended to close students of automatic transmissions. Although they are closely related to semi-automatics, Table I has been simplified considerably by omitting power shifts, conventional or manually operated syncromesh transmissions and overdrives. Following the general pattern of the automotive industry, most of these transmissions were originally introduced in the more expensive division cars, and later extended to other members of the corporate group.

Further examination of Table I will show that if details of lubricants and lubrication services are temporarily ignored, the fourteen progenitor transmissions may be reduced to five mechanical types or groups. In the following we will accordingly discuss each of the five groups, but will list the members of each group by their popular or advertising names.

THE "FLUID DRIVE"
Chrysler 1939 thru 1941
Dodge 1941 Only

Thanks to its wide acceptance coupled with the power of advertising, the highly descriptive name of "fluid drive" is often erroneously applied to practically every hydraulic transmission including even the competitives! It is correctly applied only to the Chrysler design of integral fluid coupling and conventional single-plate dry "safety" clutch which are illustrated in Figure 1 and which are inserted as a unit between the engine and a conventional manually-shifted syncromesh transmission.

ADVERTISING NAME	CAR	YEARS IN PRODUCTION	ENGINEERING DESIGNATION FOR TRANSMISSION	TECHNICAL DESCRIPTION	DRIVER OPERATION	TRANSMISSION LUBRICANT				COUPLING FLUID				REMARKS
						TYPE	CHECK PERIOD (Miles)	CHANGE INTERVAL (Pints)	CAPACITY (Pints)	TYPE	CHECK PERIOD (Miles)	CHANGE INTERVAL	CAPACITY	
Fluid Drive	Chrysler	1939-1941		Fluid coupling with 3-speed gearbox	Conventional shifting	SAE 80-SAE 160		Seasonally	2-1/4 or 3-1/2	MoPar Fluid Drive Fluid	2500		13 or 16 pints	Check period changed to 15,000 miles in 1949.
	Dodge	1941-				SAE 80 or 90		15,000	2-3/4		15,000		13 pints	
Simplimatic	DeSoto	1941-1942	M-3	Fluid coupling with vacuum operated 4-speed gearbox	Manual shift to 1st or 3rd gear; automatic upshift to 2nd or 4th gear by releasing accelerator; automatic downshift to 1st or 3rd gear by depressing accelerator	SAE 10W	2000							
Vacamatic	Chrysler													
Gyrol Fluid Drive with Tip-Toe Shift	DeSoto	1946-1948	M-5	Fluid coupling with hydraulically operated 4-speed gearbox			1000	10,000	3		10,000			
Hydraulically operated transmission	Chrysler													
Gyromatic	Dodge	1949-	M-6											Fluid coupling sealed since 1950.
Tip-Toe Hydraulic Shift	DeSoto													
Prestomatic Fluid Drive Transmission	Chrysler	1949-1950												
Fluid Matic Drive		1951-												
Fluid-Torque Drive (V-8 Models)				Torque converter with hydraulically operated 4-speed gearbox						MoPar Fluid Drive Fluid or SAE 10W	1000	20,000 Miles	10-1/2 qts	
Fluid-Torque Drive (6-Cylinder Models)		1952-		Engine fed torque converter with hydraulically operated 4-speed gearbox						SAE 5W-SAE 30		Twice Annually	13 qts (Including Engine)	
Fluid-Torque Drive	DeSoto													Early models equipped with torque converter having independent oil supply.
Gyro-Torque Drive	Dodge	1953-												Available only on V-8 models.
Hy-Drive	Plymouth			Engine fed torque converter with 3-speed gearbox	All normal driving done in 3rd gear; conventional shift to lower gears available	SAE 80		20,000	2-3/4				11 qts (Including Engine)	

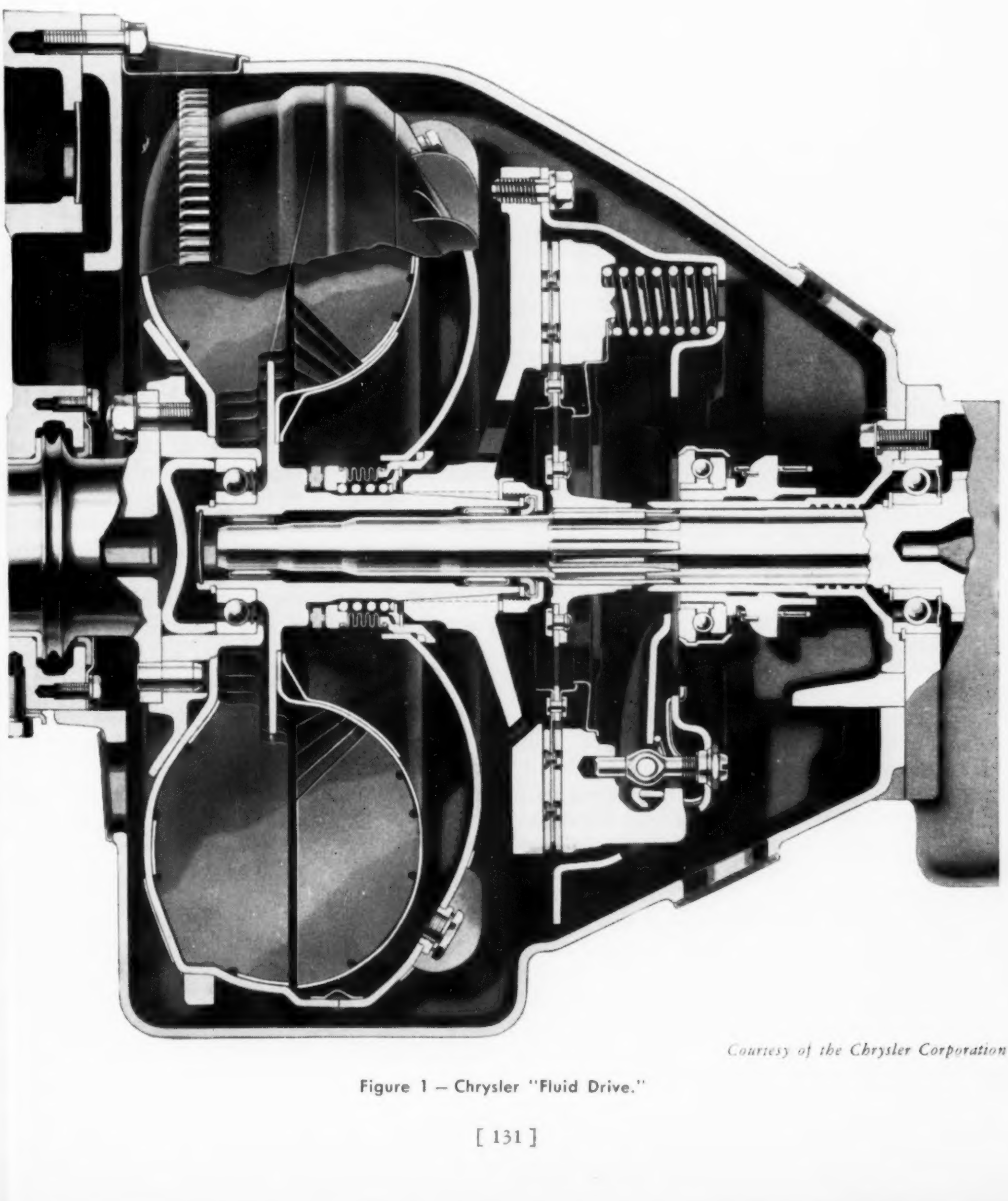
Courtesy of the Chrysler Corporation

Table I — Chrysler Corporation Semi-Automatic Transmissions. Notes: Power Shifts and Overdrives are excluded. Hyphen (-) in dates indicates "through" or "inclusive": For example "1939-1941" is read "1939 through 1941" or "1939 to 1941 inclusive."

Construction

The driving member of the fluid coupling consists of two pressed-steel shells which on final assembly are pressed and welded permanently together to form the coupling case. The interior of the forward "half" is provided with straight radial steel vanes welded to the case. The starter ring gear is thermally shrunk and welded at several points around the exterior. A heavy flange containing the ball type clutch pilot bearing and recessed to fit the engine crankshaft flange is also welded to the coupling case. The rear "half" of the coupling case is threaded at its inner diameter to receive the coupling seal and the exterior of later models is fitted with welded-on cooling vanes.

The driven member of the fluid coupling likewise consists of a reinforced pressed-steel half-torus containing straight radial vanes and welded to its central hollow bearing sleeve. The driven member has no mechanical connection to the driving member but is rotated solely by hydraulic action. Fluid is retained in the coupling by means of an ingenious and highly effective rotating seal located between the coupling casing and the hub of the driven member. The seal consists of a very finely finished graphite-carbon ring operating between the two equally-finished hardened steel bearing surfaces on the hub and the seal follower ring. As is plainly shown in Figure 1, the follower ring rotates with the case and is provided with a copper bellows and



Courtesy of the Chrysler Corporation

Figure 1 – Chrysler "Fluid Drive."

a strong helical follower spring. Since even a microscopic scratch or even corrosion from a finger print would shorten its useful life, the rubbing surfaces of the seal were manufactured with optical precision and multiple inspections and were finally assembled in special air conditioned dust-free rooms by especially trained gloved operators.

The driving member of the conventional dry single-plate clutch is keyed to the rearmost tapered surface of the coupling sleeve. The clutch driven plate is splined to the gear box input shaft which extends into and is piloted within the fluid coupling either by two needle-type roller bearings or by Oilite bushings.

Operation

With the conventional transmission in neutral, the driver starts his engine, disengages his clutch, selects the transmission gear in which he wishes to operate and reengages the clutch. Because of the presence and superior shock-absorbing capacity of the fluid coupling and the operating flexibility which it provides, clutch reengagement need not be as careful or skillful nor need the clutch be used again as long as a gear change is not made. In some designs the clutch is accordingly termed the "safety" clutch. It is entirely possible (though not very thrilling) performance-wise to start and operate the car entirely in high gear, but usual practice is to start in low or second and make a single conventional shift into high using the "safety" clutch in normal fashion. The fluid coupling is only 80% filled with fluid, and since normal engine idling speed is not sufficient to establish complete fluid-coupling action, the fluid merely tumbles erratically within part of the coupling, little engine torque is transmitted, and the car will not ordinarily begin to move. However as soon as the accelerator is slightly depressed and engine speed increases, the vanes of the coupling driving member act like a centrifugal pump by charging the fluid with kinetic energy and moving it outward in all directions. The curvature of the case then directs the fluid across the gap and into the vanes of the driven member where the energy is reconverted into mechanical torque. As in all fluid couplings, the output torque is always exactly equal to the engine's input torque, and if the output torque is greater than the car's requirement, the coupling's driven element and the car will begin to move. Under starting conditions and even though the fluid coupling can never increase engine torque, it does allow engine speed to increase up the torque curve with the result that *available* engine output torque is also increased. This action of the coupling is roughly equivalent to violently slipping a conventional clutch with the important exception that the fluid coupling can withstand a considerable amount of slippage and can safely dissipate the resultant heat without damage to itself.

Lubrication

As previously stated, the fluid coupling is partially filled with Mopar Fluid Drive Fluid, a special highly refined straight mineral oil with a viscosity of about 185 SUS at 100°F., excellent inherent oxidation stability, high viscosity index (100), excellent ability to rapidly reject air, very low natural pour point (−25°F.), ability to adequately lubricate the pilot ball bearing and seal surface, and neutrality towards the seal bellows. The fluid operates under almost ideal conditions in what is essentially a hermetically sealed case, the small amount of atmospheric oxygen initially present being removed by harmless reaction with the fluid so as to leave a residual inert (nitrogen) atmosphere. As a consequence it has not been necessary to drain and replace the fluid, and the level-check recommendation has been successively extended from the original 2,500 miles to 15,500 miles and finally to "never" — or the life of the car. Since drains and level checks were not only unnecessary but frequently harmful (through the introduction of more air, and seal-destroying dirt) Chrysler eventually left off the tempting level-inspection plugs. This mechanism is therefore one of the very few that is actually lubricated for the life of the car. There are now myriad examples of couplings that have operated well over 100,000 miles without any attention whatsoever and were still in perfect condition when the car was retired.

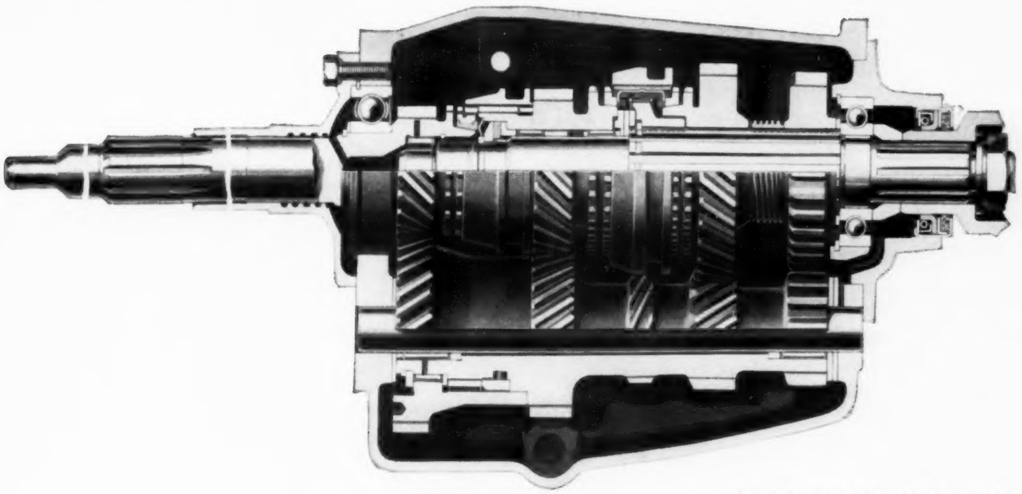
The needle bearings on the transmission input shaft and the clutch throwout bearing are all grease-lubricated during initial assembly and ordinarily require no further attention. The porous Oilite bushings which later replaced the needle bearings are inherently self-lubricating. The large ball bearing at the front of the transmission is automatically lubricated by oil from the transmission itself.

Chrysler "Vacamatic" (1941 thru 1942)
De Soto "Simplimatic" (1941 thru 1942)

Construction

The next major step in the Chrysler transmission series was to combine the fluid coupling-safety clutch assembly just described with a new semi-automatic vacuum-shifted syncromesh gear box, the latter only being illustrated in Figure 2 and designated the "M-3". The reader will recognize the leftward-projecting transmission input shaft of Figure 2 as the innermost central shaft of Figure 1.

The moving parts of the M-3 transmission comprise the transmission input shaft, a concentric but independent main shaft, the lowermost countershaft and a (hidden) reverse idler shaft which



Courtesy of the Chrysler Corporation

Figure 2 — Vacuum-shifted semi-automatic gear box Model M-3.

carry constant-mesh gears and two shiftable clutch sleeves to provide a neutral position, four forward and one reverse speeds. As will be seen, the four forward driving speeds are divided into two manually-selected driving ranges, the high range (third and fourth or direct) and the low range (first and second gears). In Figure 2 the upper half of the input and main shafts and the lower half of the countershaft have been partially sectioned to disclose several hidden but very important features described in the following numbered paragraphs:

(1) The input shaft with its integral drive pinion extends into the transmission case from the left and terminates with an integral toothed dog clutch and a conical synchronizer-clutch surface.

(2) The forward end of the mainshaft is piloted into a roller bearing within the input drive pinion.

(3) The left-hand gear on the mainshaft (called the "third speed gear") rotates freely on two sets of needle bearings, but its forward extension is splined into a slideable "direct speed clutch sleeve" while its rearward extension carries the teeth of a dog clutch and a conical synchronizer-clutch surface.

(4) The next rearward gear on the mainshaft (called the "first speed gear") can rotate freely on a plain bearing on the mainshaft, but its forward extension also incorporates the teeth of a dog clutch and a conical synchronizer-clutch surface.

(5) The rearmost spur-type gear on the mainshaft is splined to it and meshes with the slideable reverse idler gear (not shown) which in turn meshes with the right-hand spur gear on the countershaft to provide reverse gear.

(6) Though the left-hand gear on the countershaft (sometimes called the "free-wheel gear") may seem to be integral, it is separately mounted on needle bearings on the countershaft and contains a cam-and-roller type one-way clutch assembly which permits it to be driven *by* the transmission input shaft pinion, while preventing any drive in the opposite direction.

(7) The large right-hand "manual sleeve" lying between the "third speed" and "first speed" gears but splined to the mainshaft is linked to the driver's transmission range selector lever on the steering column. Figure 2 illustrates its central or disengaged position which provides a neutral position for the transmission. When shifted to the rear (reader's right) it engages the dog clutch teeth on the large first-speed gear, locks it to the mainshaft and thereby establishes the low speed range with its first and second speeds. In its forward (or reader's left) position the sleeve similarly engages the dog clutch teeth of the third-speed gear, locks it to the mainshaft and thereby establishes the high speed range with its third and fourth speeds.

(8) The smaller direct-speed clutch sleeve (on the reader's left) is splined to and always rotates with the third-speed gear. Figure 2 shows it in its inactive rearmost position in which it is held by external springs and where it establishes either third gear or first gear (depending upon the position of the manual sleeve). When energized by the electro-vacuum transmission control system, a vacuum power unit located outside of the transmission releases its force and allows another spring to push the third speed sleeve forward against the synchronizer-clutch of the transmission input shaft. As soon as speed synchronization with the transmis-

sion input shaft is obtained, the direct-speed clutch sleeve moves all the way into its forward position where it engages the dog clutch teeth of the input shaft, thereby locking the third speed gear to it and shifting the transmission either from first to second speed or from third to fourth (high) speed, depending upon the position of the manual clutch sleeve. It must be remembered that the presence of the over-running clutch in the countershaft free-wheeling gear makes such a shift possible.

(9) Two different type of electro-vacuum power and control systems have been used to determine permissible shift-speeds. Both used a flyball type governor containing electrical contact points and driven by the small spiral gear in the center of the transmission countershaft. Both also used "kick-down" contact points at the carburetor, and an ignition interrupter switch to permit the driver to overrule the governor and obtain a forced down-shift into the more powerful third (or first) gears.

(a) The Diaphragm Type Control System employs a spring-loaded vacuum diaphragm. When car speed is increased sufficiently to *open* the governor contact points, a solenoid-operated vacuum valve is de-energized to admit engine manifold vacuum to the diaphragm, compress its spring, and allow the direct speed clutch sleeve to move forward. A latch on its stem holds the diaphragm in this position even if vacuum subsequently decreases. When the solenoid is energized by closing either the governor or kickdown points, the latch is released and atmospheric air admitted to the diaphragm to cause the transmission to return to third (or first) gear.

(b) The Piston Type Control System uses a spring loaded vacuum piston with a solenoid valve and holding-coil electrically connected in series with the ignition switch. The holding-coil with its own contact points within the vacuum piston serves the same purpose as the latch of the diaphragm type. When car speed is increased sufficiently to open the governor points, a switching relay energizes the solenoid valve which admits engine vacuum to the vacuum piston, compresses its internal spring, closes its holding-coil contacts and allows the direct speed clutch to move forward and upshift into its second or fourth speed position. Subsequent closure of either the governor or kickdown points causes the switching relay to de-energize the solenoid valve and holding-coil, shut off vacuum and admit air to the vacuum piston and permits its strong internal spring to return the direct speed clutch to its third (or first) gear position.

(10) The following table will assist in understanding the mechanical operation of this transmission.

TABLE 2

Gear Range	*Direct Sleeve Clutch Position*	*Manual Clutch Position*	*Reverse Idler Gear*
Neutral	Rearward	Central	Forward
First (Low)	"	Rearward	"
Second	Forward	"	"
Third	Rearward	Forward	"
Fourth (Direct)	Forward	"	"
Reverse	Rearward	Central	Rearward (Engaged)

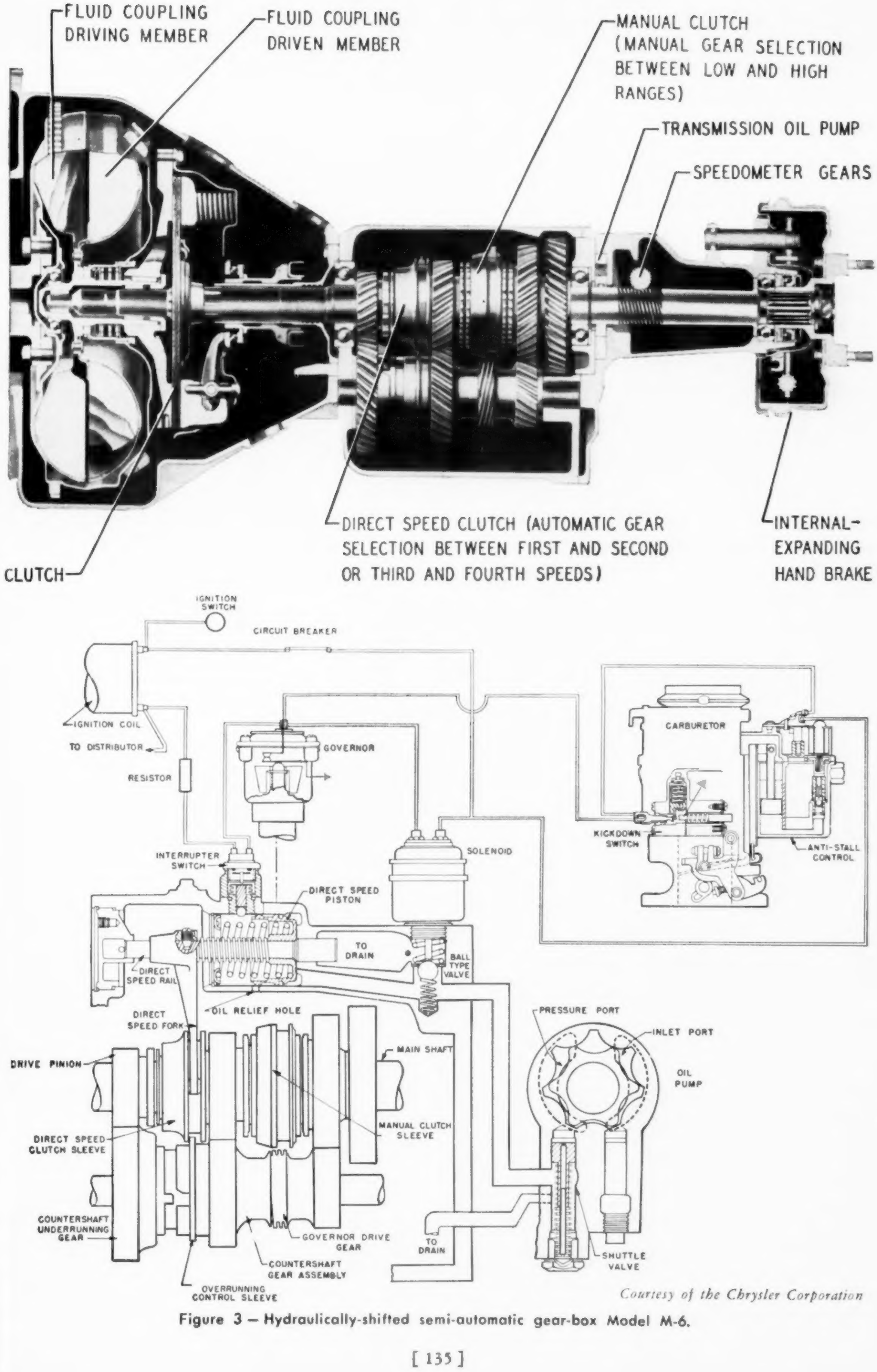
Operation

The driver starts the engine and with "safety" clutch depressed or disengaged, selects the transmission range (High, Low, Neutral or Reverse) in which he wishes to operate. Since the ratio of the third gear of the high range is more than ample for both a static start and rapid acceleration, the high range is normally used and we will assume this selection. Upon reengaging the clutch, the car normally will not move until the throttle is opened a little and engine speed is increased. As soon as the car has attained any speed above about 14 mph. (or 7 mph. if in Low range) the driver merely and momentarily releases his accelerator pedal, the vacuum diaphragm is energized, and the direct speed clutch moves forward to almost instantaneously accomplish a shift into high or direct. The transmission then continues in high unless the driver "kicks down" or the car speed decreases under closed throttle to less than 12 mph, when the governor takes over and causes a fully automatic downshift into third gear.

When the transmission is in either first or third speed, the one-way clutch is active and the car cannot drive the engine. However a "dead battery" start is readily obtained by placing the transmission in high range, pushing (never pulling) the car until a speed of between 15 and 25 mph. is obtained, turning on the ignition, momentarily depressing the "safety clutch" (to obtain a shift into high gear) and reengaging the clutch to crank the engine.

Lubrication

Lubrication of the fluid coupling-safety clutch portion of this transmission has been previously described. The four-speed gearbox is generously designed to operate winter and summer on only three pints of a good quality motor oil of the SAE 10W viscosity range.



Courtesy of the Chrysler Corporation

Figure 3 — Hydraulically-shifted semi-automatic gear-box Model M-6.

De Soto "Gyrol Fluid Drive with Tip-Toe Shift" — 1946 thru 1948

Chrysler "Hydraulically Operated Transmission" — 1946 thru 1948

Dodge "Gyromatic" — 1949 thru 1954

De Soto "Tip-Toe Hydraulic Shift" — 1949 thru 1953

Chrysler "Prestomatic Fluid Drive Transmission" — 1949 thru 1950

Chrysler "Fluid Matic Drive" — 1951 thru 1953

Construction

While these six transmissions naturally vary in some details, they all belong to the same general type, namely the Chrysler fluid coupling and clutch assembly driving a semi-automatic hydraulically-shifted four speed gear box. Figure 3 will illustrate the major components. The fluid coupling and clutch assembly has been previously described. The general arrangement and gearing of the gearbox is also quite similar to the preceding Chrysler Vacamatic (or De Soto Simplimatic) with the important exception that the subject gear box is upshifted by hydraulic pressure. Figure 3 will be used to describe the hydraulic shift which is accomplished through the following major mechanisms:

(1) Either a gear type or "rotary" oil pump (depending upon the model) is built around and driven by the transmission output shaft. The pump is of sufficient capacity to generate a pressure of about 40 psi. when the car is moving faster than 12 mph.

(2) Referring again to Figure 3 it will be seen that the direct speed clutch sleeve is shifted forward primarily by means of oil pressure applied to the right-hand side of a cup-shaped hydraulic piston. Closer study, however, will show that an "engaging spring" is interposed between the hydraulic piston and the direct speed clutch fork, consequently the piston merely "cocks" or "arms" the spring which exerts pressure on the direct speed clutch sleeve while speed synchronism is being established and then moves the sleeve into complete engagement with the dog clutch teeth of the main drive pinion. By means of an oil relief hole, the piston also serves ingeniously as an oil pressure relief valve for the transmission's oil pump.

(3) To facilitate a downshift, an electrical interrupter switch is provided which is connected into the primary side of the engine's ignition system. As the hydraulic piston moves to the right, a cam surface on it contacts and momentarily raises the ball of the interrupter switch which closes its contact points and actually shorts out or cuts off engine ignition for a fraction of a second. This interval is so short that none but a highly trained observer can even detect it, however it is long enough to secure a reversal of torque through the gear box which facilitates the shift.

(4) The remainder of the transmission control system is electrical but so designed that if no battery current is available the transmission will remain in third (or first) gear and a push start can be obtained just as previously described for the vacuum shifted transmission.

(5) Admission of oil from the pump to the shift piston is controlled by an electric solenoid valve, which in turn is controlled either by a speed governor driven by the transmission countershaft or by "kickdown" contacts at the carburetor.

Operation and Lubrication

These are essentially identical to those previously described for the vacuum-shifted transmissions.

Chrysler V8 "Fluid-Torque Drive — 1951 thru 1953

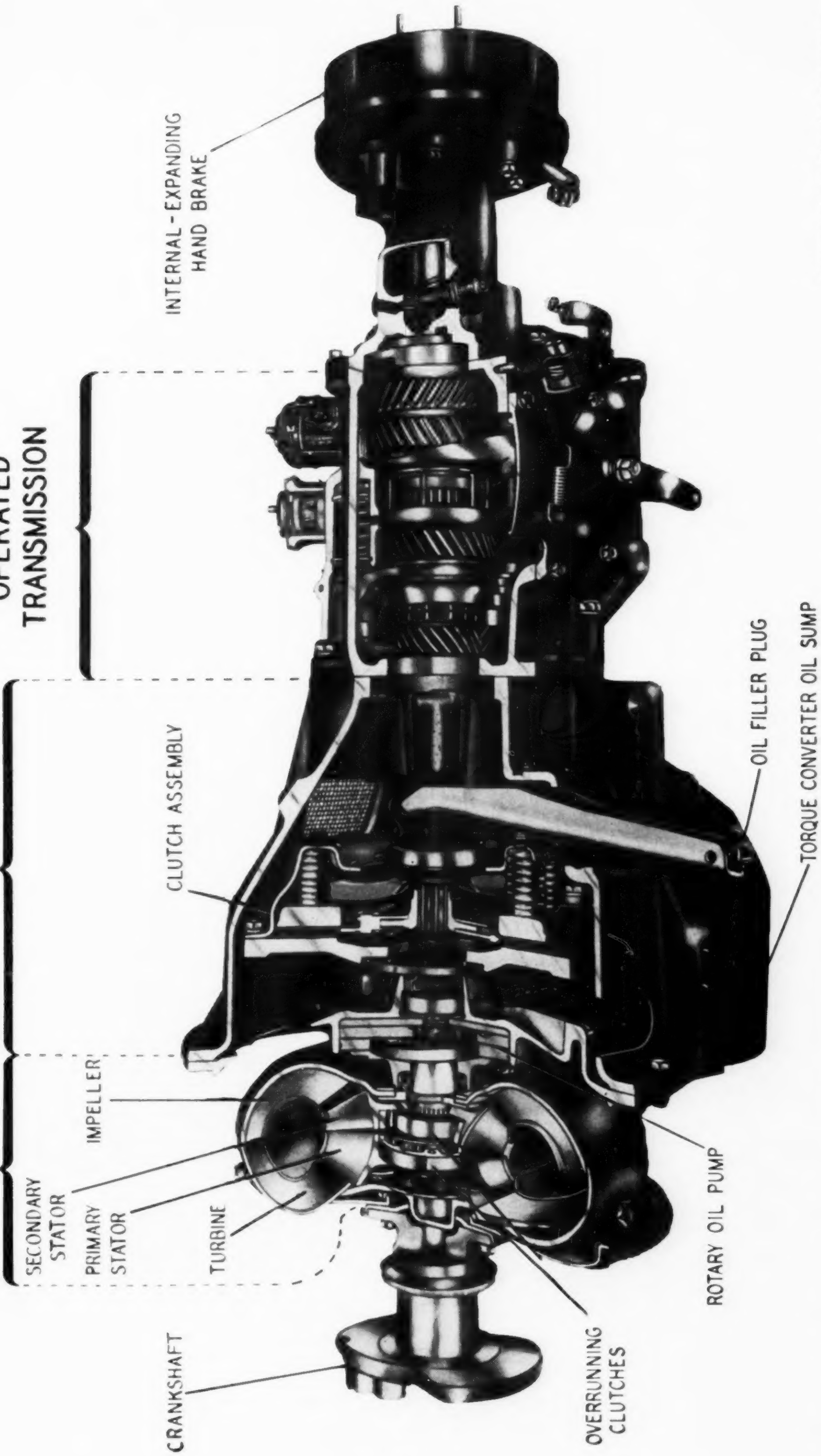
Chrysler 6 "Fluid-Torque Drive" — 1952 thru 1953

De Soto 6&V8 "Fluid-Torque Drive"—1952 thru 1953

Dodge V8 "Gyro-Torque Drive" — 1953 Only

Construction

While minor details of construction must vary among these four transmissions, they are grouped together because all of them comprise a four element combination torque converter and fluid coupling (commonly shortened to "torque converter"), driving the now-familiar Chrysler hydraulically shifted semi-automatic four speed gear box through a conventional clutch. In other words, the major difference between them and the group just previously described is the replacement of the simple fluid coupling with a full-fledged torque-multiplying torque converter. Figure 4 will serve to represent the group in general, though it is entirely applicable only to the first above and to some early models of the third, which had converters with independent separate fluid systems. The converter in Figure 5 (The Plymouth Hy-Drive) is representative of the engine-fed converters composing the remainder of this group. As indicated by its name, the four-element converter-coupling consists of (1) an impeller or centrifugal pump built into the rear of the converter case and the whole driven



Courtesy of the Chrysler Corporation

Figure 4 — Combination converter-coupling with hydraulically-shifted semi-automatic gear-box.

by the engine, (2) a turbine or runner connected to the converter's output shaft, (3) a primary stator or reaction wheel mounted on an over-running or one-way clutch and a stationary extension of the clutch housing so that the stator can turn freely in the *same* direction as the impeller and pump, but can not turn in the opposite direction, (4) a secondary stator very similar to the primary except that the curvature and angle of its blading is different. The stators are the major difference between a converter and a fluid coupling and are directly responsible for the torque multiplying ability of the converter.

As indicated in Table I, the converter in some of these transmissions has its own separate special fluid supply, and keeps itself filled under pressure by means of its own oil pump as illustrated in Figure 4. The other converters of this group however, are "engine fed," that is, they have no pump of their own but are connected to the engine's lubrication system and utilize engine oil.

Operation

It may be recalled from previous articles that a torque converter of this type is a fully automatic transmission in itself which, as a torque converter can multiply engine torque by as much as 2.6 times, yet can automatically change to a fluid coupling operation and transmit engine torque unchanged. The primary factor which determines whether the converter-coupling will operate as a converter or as a coupling is the ratio between its output and input speeds. The input speed is of course the engine's speed; the output speed is determined by the torque imposed on the converter runner, i.e., the torque requirements of the vehicle.

The hydraulically shifted transmission also multiplies torque though by mechanical rather than hydraulic means. In its third or normal starting gear its own torque multiplication (or gear) ratio is 1.61, therefore in combination with the converter, the transmission increases engine torque by 2.6 x 1.61 or 4.18 times.

To start and move a car equipped with one of these transmissions, the driver first places his steering column selector lever in the neutral position and starts the engine. He then depresses his clutch pedal, moves the selector lever to the speed range (usually high range) that he intends to use and reengages the clutch. Even at low engine idle speed, the torque converter can still multiply torque, therefore the car may begin to move slowly or "creep." In any case a touch of the throttle will increase engine speed, bring the converter into full action, and the car will accelerate rapidly under the combined torque multiplying effects of converter and gear box. A momentary release of the throttle causes the gear box to shift into high or direct. Depending on the throttle opening subsequently adopted, the converter may still multiply torque or merely act as a coupling. Under *full* throttle acceleration the converter will gradually decrease its torque multiplication ratio up to a car speed of about 50 mph and thereafter act as a coupling. On the other hand if throttle opening is moderate and constant, the car will "catch up with the engine" and fluid coupling operation will be established even as low as 20 mph.

Lubrication

Lubrication of the hydraulically operated gear box has been previously described. Those torque converters having a separate and independent fluid system are filled with Mopar Fluid Drive Fluid like the Chrysler fluid couplings. But unlike the fluid couplings, the fluid in these converters *is* in contact with atmospheric oxygen (in their fluid sumps) therefore the fluid will eventually oxidize and must be replaced at the regular intervals indicated.

The engine-fed torque converters in this group must obviously use the viscosity grade of engine crankcase oil that atmospheric temperatures will dictate for the engine. Because they form a "pocket" in the engine's lubrication system, they must be separately drained when the engine crankcase is drained.

Plymouth "Hy-Drive" Transmission — 1953 thru 1954

Construction

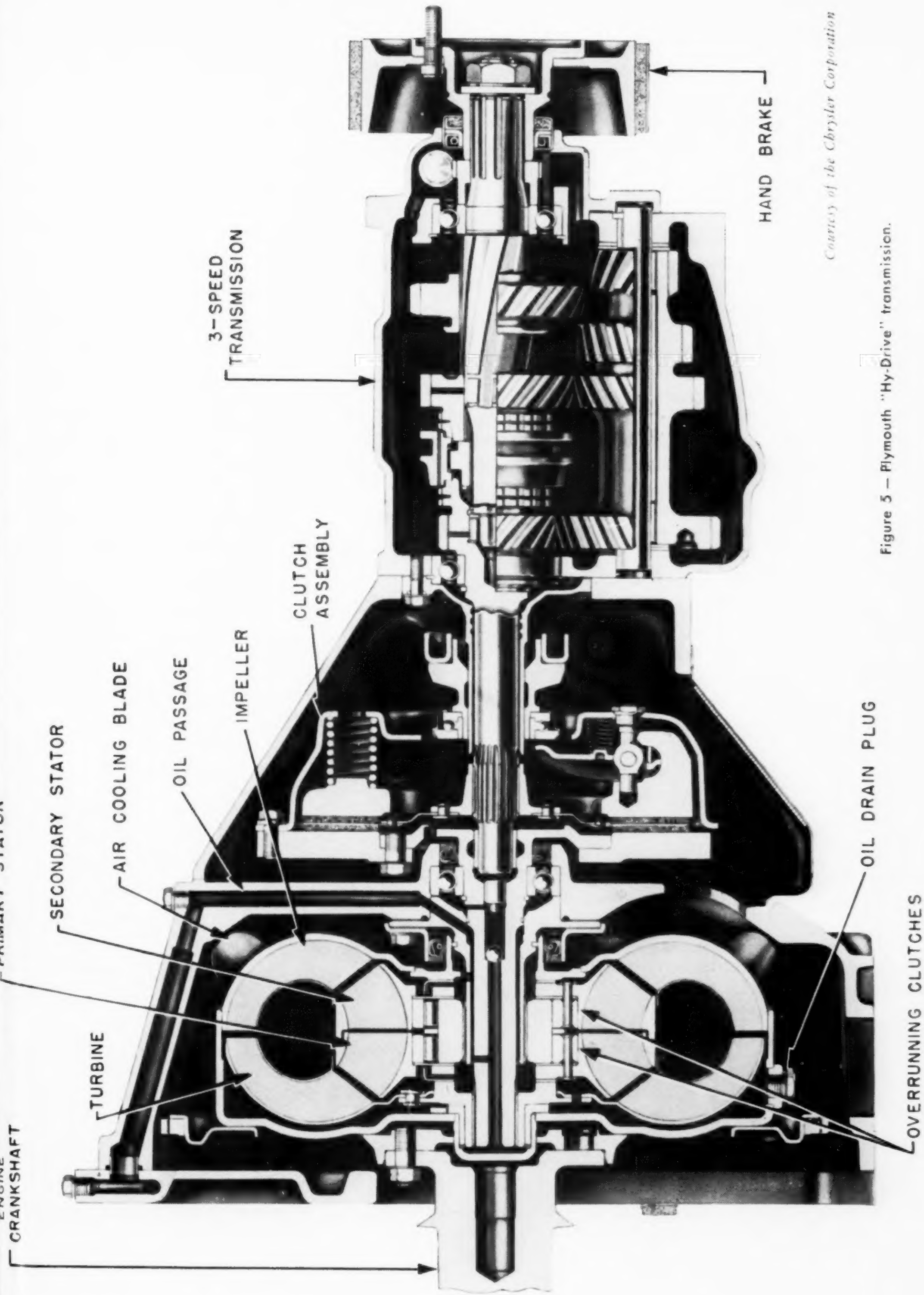
A little study of Figure 5, a cross sectional view of the Hy-Drive, will indicate that it consists of an engine-fed four-element converter-coupling driving a three-speed manually-shifted syncromesh gear box through a conventional manual dry clutch.

Operation

The driver handles the Hy-Drive much as if it were only a conventional manual transmission. But since the converter coupling is in itself a fully automatic and powerful multiplier of engine torque, it adds immeasurably to the smoothness and performance flexibility of the assembly. In truth the name "Hy-Drive" is derived from the fact that the car can be started smoothly and fairly nimbly even when the conventional transmission is in high gear, and all subsequent normal driving is done in high. Where high performance is desired, the conventional transmission is started out in second or even low gear and a single normal shift made into high whenever convenient.

Lubrication

Being engine-fed, the converter is automatically provided with the identical engine oil being used



Courtesy of the Chrysler Corporation

Figure 5 — Plymouth "Hy-Drive" transmission.

in the engine's lubrication system, but must be drained separately from the crankcase. Due to converter action, the entire engine lubrication system warms up more quickly from a cold start but operates very little warmer thereafter than a conventional engine system. The syncromesh transmission is separately lubricated year-round with an SAE 80 gear lubricant.

The Chrysler PowerFlite Automatic Transmission

All of the Chrysler transmissions previously described in this issue have been of the semi-automatic type, since each required the driver to consciously perform one or more manual preparatory actions (such as clutch manipulation, or momentarily closing the carburetor throttle) as a signal before the semi-automatic transmission could accomplish a gear shift. On the other hand, the Chrysler PowerFlite transmission which we are about to describe is *fully* automatic, the first such of Chrysler manufacture. Furthermore, the manufacturer claims that of all full automatics the Powerflite is the lightest, the smoothest in action and the least complex (fewer parts) in construction.

The design has been so worked out that with only two converter diameters (nominally 11¾" and 12½") and a minimum of other modifications, the Powerflite is readily adapted to the large range of engine powers, sizes and types available in Chrysler Corporation automobiles and is now available in the entire Chrysler line.

Construction

To the initiate, a glance at Figure 6 will suffice to generally identify the latest PowerFlite as a three-element converter-coupling driving two planetary gear sets which are controlled by two bands and a multiple disc clutch. Early PowerFlites used a four-element converter. Other important components not so readily evident are six basic and three "refining" hydraulic control valves, a governor, and the two oil pumps which are now common to all automatics. The conventional clutch and clutch pedal are conspicuously absent.

Converter-coupling

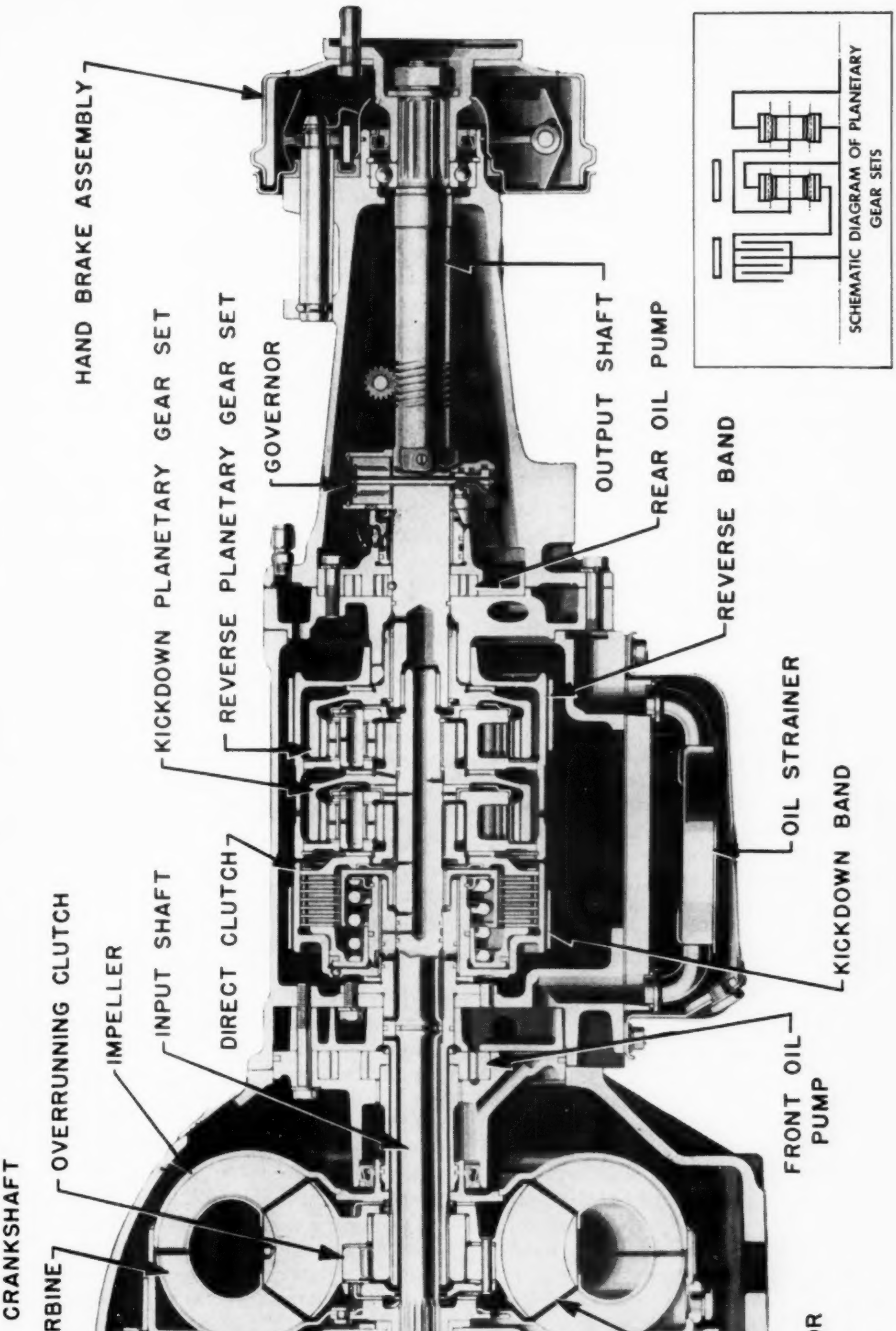
The two pieces of the pressed steel case enclosing all elements is permanently welded after assembly, and is rigidly bolted to the crankshaft flange without anything resembling the flexible disc that is employed in some competitive designs. The steel impeller or pump blading is both straight and radial, and is brazed to the rear half of the converter case. The turbine or runner is similarly constructed of steel vanes brazed into a steel half-torus the hub of which is splined to the converter output shaft. The single stator is an aluminum casting with integral steel cams for a cam and roller type "overrunning" or "freewheeling" clutch. The converter-coupling is claimed to have the highest torque multiplication ratio at stall (2.6) of any, yet its range of operation is also very extensive as indicated by the fact that it automatically changes to fluid coupling operation whenever the turbine to impeller speed ratio is more than 0.87. Converter fluid is cooled by a conventional oil-to-water heat exchanger on the front of the engine block on some models and by *air* cooling on others.

Planetary Gears

As indicated in Figure 6 the converter's turbine is *always* connected to one set of plates in the multiple disc clutch, to the annulus or ring gear of the front planetary and to the sun gear of the rear. Output torque from the entire transmission is *always* taken from the annulus or ring gear of the rear planetary. The planetary carriers of both planetaries (each with three pinions) are connected together and may be stopped and held stationary by application of the rear band. The sun gear of the front planetary is connected to the clutch cylinder with its five or six cork-and-Krafelt faced clutch plates and the entire assembly may be stopped and held stationary by application of the front band. By automatic manipulation of the clutch or the two bands, the planetaries will thus product a low forward speed of 1.72 ratio, a high forward or direct speed of 1.0 gear ratio, an automatic shift from low to high, a neutral position, and a reverse speed of 2.39 ratio. For the entire transmission these ratios are of course multiplied by the converter torque ratio which varies in an infinite series from 2.6 maximum at stall to 1.0 for fluid coupling operation. The combined transmission torque multiplication ratio is of course further multiplied by the gear ratio of the rear axle with the result that engine torque can be readily increased as much as 15.02 times (low-forward) or even 20.85 (reverse operation) by the time it reaches the driving wheels. Referring again to Figure 6, the transmission's hydraulic control system directs planetary action as follows:

TABLE 3
PowerFlite Planetary Gear Operation

Gear	*"Direct" Disc Clutch*	*Front or "Kickdown" Band and Low Servo*	*Rear or "Reverse" Band and Reverse Servo*
Neutral	Released	Released	Released
Low	"	Applied	"
High	Applied	Released	"
Reverse	Released	"	Applied



Courtesy of the Chrysler Corporation

Figure 6 — Chrysler "PowerFlite" full automatic transmission.

Hydraulic Control System

Though no automatic transmission control system could truthfully be called simple, that of the PowerFlite is the simplest. Within the space limitations of this article we will not attempt a complete explanation of all functions but will furnish sufficient information so that an avid student not possessing the several complete manufacturers' manuals can at least work out the main functions of the hydraulic control system.

Figure 7 is a schematic diagram of the PowerFlite's hydraulic control system when the transmission is operating in its Drive range: used in conjunction with Table 3 and the following descriptions, the principles of operation can be clarified. Of casual interest is the fact that the upper left portion of Figure 7 illustrates the original four-element converter.

The selector "Indicator" or quadrant is one of the driver's two controls over the transmission and is mechanically linked to the Manual Valve within the transmission. The selector lever positions are "R" (Reverse), "N" (Neutral), "D" (Drive) and "L" (Low), an arrangement again different from other transmissions (there being no standardization in this matter to the confusion of all drivers) but determined after considerable study. The mechanical stops or "gating" of the selector lever is the simplest yet devised and readily permits the driver to "feel" into any position without seeing the indicator. The lowest slot of the gate in which the control lever normally and naturally remains contains only the Neutral and Drive positions. By pulling the selector lever slightly toward the driver, Reverse and Low are obtained. The engine can be started *only* when the transmission is neutral. It should be noted that a Parking position is not required nor used. The hand brake behind the transmission provides maximum holding power and will in fact hold in any range with the engine at wide open throttle.

Oil Pumps

The front or larger pump which is engine-driven, has a theoretical capacity of 3.75 gpm @ 1000 rpm, and furnishes transmission requirements at lower car speeds. The rear pump with a capacity of 2 gpm @ 1000 rpm is driven by the transmission's output shaft and takes over transmission requirements at forward car speeds higher than about 35 mph. It does not operate in reverse. The pumps have a common intake oil strainer and each is provided with a discharge check valve to prevent reverse flow.

The Regulator Valve is designed to maintain a basic steady transmission oil line pressure of 90 psi in Neutral, Drive, and Low and 250 psi in Reverse without regard to engine throttle position nor car speed. It also delivers oil to the TORQUE CONVERTER Control Valve.

The Torque Converter Control Valve in conjunction with a fixed orifice on the converter's discharge line, reduces line pressure and maintains a maximum pressure in the converter of 60 psi. Oil leaving the converter flows to the transmission's lubrication system either directly (as in air-cooled converters) or by way of the oil cooler in water cooled installations.

The Manual Valve is directly controlled by the driver and directs oil under line pressure to the several valves and servos that are to be used in the selected driving range. In Reverse position this valve increases line oil pressure from 90 to 250 psi by removing pressure from part of the reaction surface in the regulator valve, or in effect increasing the strength of the latter's spring.

The Throttle Valve is mechanically linked to the carburetor throttle but is effective only in the Low and Drive positions. It reduces line pressure to a value proportional to throttle opening which varies from about 15 psi at closed throttle to full line pressure of 90 psi at wide open throttle. It helps to establish the car speed at which an upshift will occur for any given position of the accelerator, and assists in maintaining smooth shifts by modulating the oil pressure to bands and clutch in approximate proportion to the torque load imposed on them. It and the Manual Valve are the driver's "resident representatives" in the transmission.

The Governor Valve revolves with the transmission's output shaft and modifies line pressure to produce one that is closely proportional to car speed. It and the Throttle Valve work together to determine the car speed at which an upshift is made. During a "kickdown" or forced downshift it similarly works with the Shuttle Valve (to be described) to insure maximum smoothness of shift.

The Shift Valve with oil from the Throttle Valve working on one face and oil from the governor valve on the other, is like a general manager working under two vice presidents since it must adjudicate their opposing instructions, decide exactly when an upshift should be made, and then apply enough pressure to the subordinate clutch and servos which make the shift. Like any good executive, once having decided *when* to move, the Shift Valve must make that move with dispatch and literally snap into its final position lest it cause unnecessary confusion, cross purpose and slippage. In the Powerflite, the desired "snap action" of the Shift Valve is obtained by clever usage of four orifices (A, B, C, D in Fig. 7) to suddenly unbalance the balance just obtained between the opposing throttle and governor pressures.

The Shuttle Valve provides for a smooth upshift

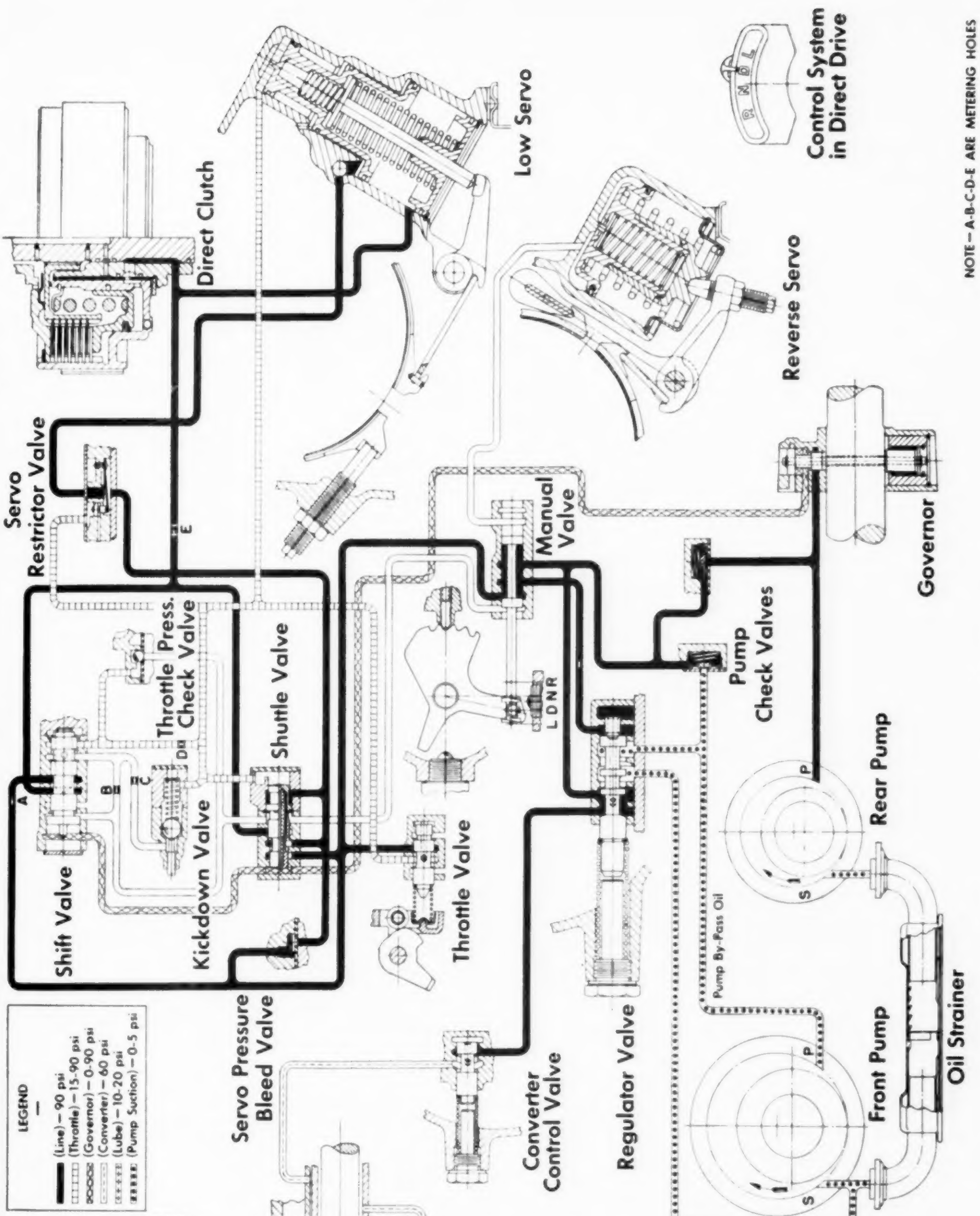


Figure 7 — Chrysler PowerFlite transmission hydraulic circuits (Direct Drive condition).

Courtesy of the Chrysler Corporation

into high should the driver suddenly interrupt a full throttle acceleration (in low gear) by releasing the accelerator momentarily. This is accomplished by joining the releasing and applying pressures in the kickdown servo. Its second and somewhat similar function is to provide smoothness during a forced down-shift or "kickdown." During a kickdown the clutch must release and the kickdown band should take hold exactly when engine speed has increased 1.72 times (the low gear ratio) more than it was in high gear just before kickdown. If the kickdown band should take hold too soon, the car will have to accelerate the engine to its new speed, and a "bump" results. On the other hand if the band engages too late, the engine will have accelerated beyond its proper speed, the car will have to drag it back into synchronism and an "overspeed bump" occurs. The Shuttle Valve assists in avoiding both of these kickdown bumps by increasing the speed of application of the kickdown servo at low car speeds and decreasing it at high.

The Kickdown Valve is mechanically opened when the driver opens his throttle widely or "steps on it." When opened, it downshifts the Shift Valve which in turn vents oil from both the direct clutch and the kickdown servo "off" area, thus returning the transmission to low gear. Two orifices in the throttle pressure line to the Shift Valve insure that the resultant force is reduced to less than the opposing force created by governor pressure, thereby preventing a kickdown if car speed is greater than about 55 mph.

Operation

Operation of the PowerFlite is exceedingly simple. After placing the selector lever in Neutral (by merely pushing it upward) the engine is started and the selector lever then moved to the desired driving range which we will assume is "Drive." With release of the parking brake, a touch of the accelerator moves the car smoothly forward. The shift into high occurs somewhere between 17 and 65 mph (the exact speed depending primarily upon throttle position and to a lesser extent the car model) and is ordinarily so smooth as to be undetected. Subsequent brilliant acceleration in high gear up to nearly open throttle in assisted automatically by torque converter action: even greater acceleration up to 55 mph is obtained by "kickdown" of the planetaries into low gear.

If the selector lever is placed in Low range, the transmission will not upshift under any circumstance, consequently this range provides both a powerful hill-pulling gear and a very effective means of obtaining engine braking during the descent of very steep hills. The transmission may be shifted into Low range at car speeds up to 65 mph.

Rocking the car in mud and snow is easily accomplished by partly opening the throttle, pulling the selector lever towards the driver and alternately moving it between Reverse and Low positions.

Should a dead battery necessitate, the engine of a PowerFlite-equipped car can be easily started by placing the selector lever in Neutral, pushing (but never pulling) the car with another up to a speed of about 25 mph, turning on the ignition and then moving the selector lever to Low in order to crank the engine.

Lubrication

The PowerFlite is the first and only one of the Chrysler transmission family which utilizes a single fluid to fill the converter-coupling and to lubricate or otherwise function in the gear box, control system and in fact the entire transmission. The promotion of smooth clutch and band action, the reduction of thermal viscosity effects on the hydraulic control system, the elimination of any possibility of foaming, the ability to function at very low temperatures, the preservation and rust prevention of critical transmission parts and the desirability of proven high oxidation resistance all require that the PowerFlite be lubricated with from 10 to 11 quarts (depending on transmission model) of a fully qualified Automatic Transmission Fluid Type A. The manufacturer recommends that the Type A fluid be drained and replaced with unused fluid every 20,000 miles.

CONCLUSION

The PowerFlite Transmission is the result of an evolutionary program which has included three-speed units, lock up clutches, and almost any other feature which appeared logical in the course of development. It was finally confirmed in its present form because it proved to be an outstanding combination of the characteristics most sought in an automatic transmission namely light weight, simplicity, ruggedness, dependability, performance, ease of manufacture and a new standard for smoothness of operation.

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